On the Creation of the Universe out of "nothing"

Marcelo Samuel Berman[(1)]

and Luis Augusto Trevisan[(2)]
(1) Instituto Albert Einstein/Latinamerica
Av Candido Hartmann 575 #17
80730-440 Curitiba- PR-Brasil
msberman@institutoalberteinstein.org
(2) Universidade Estadual de Ponta Grossa,
Demat, CEP 84010-330, Ponta Grossa,Pr,
Brazil email: latrevis@uepg.br

September 20, 2009

Abstract

We "explain ",using a Classical approach, how the Universe was created out of "nothing ",i.e., with no input of initial energy nor mass.The inflationary phase, with exponential expansion, is accounted for, automaticaly , by our equation of state for the very early Universe. We touch briefly on a gravitational collapse phenomenon towards "nothing". This could have implications in black hole theory; for instance, b.h. ´s evaporation is shown to happen ,in our Classical framework.

PACS 98.80 Hw; 98.80 k, 04.20 q

ON THE CREATION OF THE UNIVERSE OUT OF "NOTHING"

MARCELO S. BERMAN AND LUIS A. TREVISAN

1 INTRODUCTION

The science of cosmology has progressed up to a point where it is possible to make a valid picture of the first moment of the Universe. It is widely accepted that the creation of the Universe should be attributed to Quantum fluctuations of the vacuum. As a consistent Quantum gravity theory is not yet available, cosmologists employ General Relativity, or other classical theories, in order to study the evolution of the Universe after Planck 's time ($t \cong 10^{-43}s$).

The present authors will try to offer now a Classical picture covering the creation of the Universe. The only thing that we need to admit, is that Einstein´s field equations yield the average values for the quantities that, in the Quantum Universe, when $t < 10^{-43}s$, fluctuate quantum-mechanically around those average values, somehow like the Path Integral theory of Feynman[1]admits paths that fluctuate around the average trajectories given by the Classical theory. Throughout this paper, when we refer to the Quantum Universe, all quantities should be understood as given by the most probable values of those quantities, even if this is not explicitly stated.

Along a rather similar situation, Kiefer, Polarski and Starobinsky [2] have shown that although according to the inflationary scenario for the very early Universe, all inhomogeneities in the Universe are of genuine quantum origin, clearly no specific quantum mechanics properties are observed when looking at this inhomogeneities and measuring them. It looks like we can get along without a Quantum gravity theory, and still "explain " the origin of the Universe.

Berman (2009), shows how to calculate by means of pseudo-tensors, the zero-energy of the Universe. His calculations date the year 1981 (Berman; 1981).References on zero energy calculations for the Universe, are given by Berman(2009). It was also shown by Rosen (1994) and Cooperstock and Israelit, later, [3] that the total energy of the Robertson-Walker's Universe is zero. The total energy is the sum of the positive matter energy plus the negative energy of the gravitational field, and it is zero. Thus, in the very creation moment there was no supply of energy to the Universe, because it was not needed (see Feynman [10])

We suppose that the Universe obeyed Einstein's field equations, and Robertson-Walker's metric. As the field equations yield an expansion, the

most probable value of R (the scale factor) increases, beginning with zero value. We may suppose that the Universe obeyed the relation

$$GM = \gamma R \tag{1}$$

where γ is a constant and M is the mass of a large "sphere" of radius R. When $t = 0$, $R = 0$ and, thus, $M = 0$. As stated in next section, when relation (1) is plugged with Planck 's length R_{pl} and mass M_{pl} , we find $\gamma = 1$.Note that, when $\gamma \approx 1$, we have a Machian Universe[4]. So, our Universe needs no initial mass, at least if it is Machian.

Let us consider the balance of energy equation [5]:

$$p = -\frac{dM}{dV} \tag{2}$$

Using (1) and (2) Berman and Marinho Jr. [7] have shown how the very early evolution of such a Universe obeyed the equation of state

$$p = -\frac{1}{3}\rho \tag{3}$$

where $V = \alpha R^3$, (α=const), p and $\rho \equiv M/V$ stand for cosmic pressure and energy density.

We obtain relation (3) above, by finding, from (1), and (2) successively:

$$p = -\frac{dM}{dV} = -\frac{dM}{dR}\frac{dR}{dV} = -\frac{1}{3\alpha R^2}\frac{dM}{dR} = -\frac{\gamma}{3\alpha G}R^{-2}$$

while

$$\rho = \frac{M}{V} = \frac{\gamma R}{G\alpha R^3} = \frac{\gamma}{\alpha G}R^{-2}$$

and then, by comparing the expressions for p and ρ, relation (3) is obtained. Berman (2006) and Berman (2006a), have tied the zero total energy of the Universe to the Machian calculation of energy density and cosmic pressure done above.

Our results will be applied in section 3 to the analysis of gravitational collapse.We shall show very simply why the endpoint of the collapse may be a unique point with no mass at all.

We shall now show that the solution of the Einstein's field equations, in the $\Lambda \neq 0$ case, yields the exponential law of expansion, which in turn accounts for the "inflationary" phase devised by Guth [10] and others.

2 Solution for the Scale-Factor

Berman and Marinho Jr. [7] admitted that, for the very early Universe, the Machian hypothesis $\frac{GM}{R}=1$, which is exactly valid, when mass M and scale factor R are plugged with Planck 's mass and length [11] , could point out to an equation of state for the very early Universe, in the classical domain, and thus, not be just a coincidence , only valid for the Planck 's Universe. The resulting equation of state, that would be valid in the classical Universe domain, just after the Quantum State phase, was derived as equation (3), along with:

$$\rho = (\alpha G R^2)^{-1}. \tag{4}$$

where $\alpha = const$, that relates volume to R^3 , by means of

$$V = \alpha R^3 \tag{5}$$

In (4), G stands for Newton 's gravitational constant, while, in (3), p and ρ stand respectively for cosmic pressure and energy density.

We now propose that these results be accepted also as yielding the most probable values of the quantities they represent, even in the Quantum domain.

In ref [7], Berman and Marinho Jr. considered the $\Lambda = 0$ case, obtaining, from Einstein 's field equations, and Robertson-Walker's metric, the relation

$$R = \sqrt{\left(\frac{8\pi}{3\alpha} - k\right)}.t \tag{6}$$

where $k = 0, \pm 1$ is the tricurvature.

For the $\Lambda \neq 0$ case, Einstein's equations read, for a perfect fluid:

$$\frac{8\pi G}{3}\rho + \frac{\Lambda}{3} = +\frac{k}{R^2} + \frac{\left(\dot{R}\right)^2}{R^2} \tag{7}$$

and also

$$8\pi G p - \Lambda = -\frac{2\ddot{R}}{R} - \frac{(\dot{R})^2}{R^2} - \frac{k}{R^2} \tag{8}$$

By assuming equation of state (3), and relation (4), we find the following solution

$$R(t) = e^{\beta t} - e^{-\beta t} \tag{9}$$

where β =const (to be determined) .We can check that $R(0) = 0$.

On plugging back into equations (7) and (8), we find

$$\beta = \frac{1}{2}\sqrt{\left(\frac{8\pi}{3\alpha} - k\right)}. \tag{10}$$

We can also obtain a value for Λ,

$$\Lambda = \frac{3}{4}\left(\frac{8\pi}{3\alpha} - k\right) \tag{11}$$

When Λ goes to zero, (or βt is small, in (9)) we recover result (6). Though we worked with $\gamma = 1$, (see equation 1), similar results are obtained with $\gamma \neq 1$,if γ is still a constant. Notice that we have a graceful entrance into exponential inflationary phase, just as we enter the Classical domain. In fact, the negative exponential part of the scale-factor , can be neglected with the passage of time. For inflationary scenario, we recommend the updated book by Weinberg (2008).

3 Discussion of Results and Conclusion

Our result for the scale factor, was adopted by Berman (2009a) in a different way: here , we produce it as a solution of the field equations with the given equation of state; there , he began to write the scale-factor equation, and , then , he found the most general equation of state that could be found for that scale-factor. It turned that the equation of state (3) is a particular one in the new solution.

As far we know, our result is so good that it reduces to a known result (relation (6)) in the limit $\Lambda = 0$, so we can be confident on it. We have also shown that the equation of state (3) is valid not only for $\gamma = 1$, as in reference [6], but for any finite fixed value of γ.We remember that Λ models were considered earlier by Berman and Som [12], and others[4].

We explained how, in the origin of the Universe, a Classical,picture, given by the most probable values for the Quantum, picture, coinciding with their classical functions , do not require input of initial energy nor initial mass; just, we need valid the Einstein field equations and R.W's metric . Thus, we have a consistent picture of the creation of the Universe, out of "nothing ".

As the Robertson-Walker's metric is time symmetric, we may now choose the inverse of the evolutionary phenomenon, i.e, gravitational collapse, and, if $\gamma \geq 1/2$, we have a black hole candidate. However, the end point of such

gravitationally collapsing matter, is not a point of infinite energy density and finite mass , but as we have shown in the inverse situation, the final mass is zero valued; all mass has disappeared at the endpoint.We are left with "nothing". This result must be taken into account when one studies black-hole theory, so as to validate the conservation of (zero) total energy, in our Classical black hole evaporation picture (of course, we have fluctuations of energy due to Quantum uncertainties,but we concentrate on the most probable values, during the last $10^{-43}s$) . On the other hand we have found an equation of state and a solution for the scale factor in the $\Lambda \neq 0$ case that implies the inflationary phase, automatically, for the very early Universe.

Acknowledgments

M.S.B thanks support of Geni, Albert and Paula.

References

[1] Feynman, R.P; Hibbs, A.R.–"Quantum Mechanics and Path Integrals", Mc-Graw-Hill, New York(1965)

[2] Kiefer,C.;Polarsky, D.;Starobinsky,A.A–gr-qc/9802003.

[3] Cooperstock, F.I; and Israelit M, –Found of Physics **25**:(4), 631, (1995)

[4] Weinberg,S.– "Gravitation and Cosmology ", Wiley, New York(1972)

[5] Adler,R.; Bazin, M.; Schiffer, M– "Introduction to General Relativity "2nd edtn–McGraw-Hill,New York (1975)

[6] Berman,M.S; (1981) M.Sc. Thesis, Unpublished, Instituto Tecnologico de Aeronautica, São Jose dos Campos . Available online through the federal govermnent site www.sophia.bibl.ita.br/biblioteca/index.html. (suply author´s surname and keyword "Einstein")

[7] Berman,M.S; Marinho Jr,R.M –Astrophysics and Space Science, **278**, 367-369 (2001)

[8] Berman, M.S. (2009) *On the zero-energy Universe,* International Journal Theretical Physics, to be published -DOI 10.1007/s10773-009-0125-8

[9] Berman, M.S. (2009a) *General Relativistic Singularity-Free Cosmological Model*- Astrophysics and Space Science **321**, 157

[10] Guth,A.–Phys Rev **D 23**, 247, (1981).

[11] Berman,M.S –Astrophysics and Space Science **222** 235 (1994).

[12] Berman,M.S;Som,M.M., –Phys. Letters **142A** 338. (1989)

[13] Feynman, R.P.–´´Lectures on Gravitation“ class notes taken by F.B. Morinigo and W.C. Wagner, Addison Wesley (1962-63)

[14] Rosen, N. GRG **26** 319 (1994). See also GRG **27** , 313 (1995)

[15] Weinberg, S. (2008) - *Cosmology* , Oxford University Press, Oxford.